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THE NOCTURNAL FLIGHT OF MIGRATING BIRDS.

BY O. G. LIBBY.

IT HAS long been a well-known fact of bird life that, during the migrating season, most, if not all, of the movement north or south takes place in the night. This ensures protection from enemies and opportunity for securing food during periods of rest. Under the cover of darkness, the bird passes safely and secretly through the air. During the day he can search for necessary food and by evening he is again ready to continue his flight.

But the very conditions that shield the migrating birds from danger, also preclude any very satisfactory study of their movements. We know, to be sure, that during the fall migrations, most of the large flocks will be found in the early morning on the north side of groves or belts of timber, and in the spring they are to be found on the south side. We know, too, from observations covering a long period of time that birds are seen in the morning which were not in the neighborhood the day before. And most bird lovers know how distinctly the calls of the migrating birds can be heard during the nights of middle September. Still it must be confessed that in proportion to the magnitude of this movement in the bird world and the importance of the interests at stake, economical as well as biological, our actual knowledge of the migration is exceedingly meager.

The writer has recently made two sets of observations upon the nocturnal flight of birds, an account of which may prove interesting to the general reader. The place of observation first selected was a small elevation west of the city of Madison, Wisconsin, with three lakes in the immediate vicinity. The evening chosen (September 14, 1896) was chilly and a raw southeast wind was blowing, though there were no clouds during most of the time. A total of three thousand eight hundred bird calls were recorded, an average of twelve per minute. This rate, however, varied greatly, sometimes running as high as two or three per second and again falling to about the same number per minute. The largest number of calls counted for any hour was nine

hundred and thirty-six, between two and three o'clock, though nearly that number were noted for two other hours. Nor were the calls at all confined to the few hours during which they were recorded. They began much earlier in the evening and when the observations ceased, at a little after three, they were heard steadily on long after that hour, with the regularity of the ticking of a clock. Manifestly it is quite impossible to estimate the number of birds represented by these calls. The equation contains so many unknown quantities that no satisfactory mathematical solution is to be expected with our present knowledge of the subject. But it may be very safely assumed that the number of calls must be multiplied many times to express even approximately the size of the flocks that were heard to pass during the course of the observation.

Nothing but an actual experience of a similar kind can at all adequately convey the impression produced by such observations. The air seemed at times fairly alive with invisible birds as the calls rang out, now sharply and near at hand, and now faintly and far away. Repeatedly it seemed as if some of the nearer ones must be visible, so vividly was their presence felt as they passed overhead. All varieties of bird calls came sounding out of the darkness that evening. The harsh squawk of a water bird would be followed by the musical *chink* of the Bobolink. Almost human many of them seemed, too, and it was not difficult to imagine that they expressed a whole range of emotions from anxiety and fear up to good-fellowship and joy. The fine shrill notes of the smaller Sparrows or Warblers were heard only close at hand but the louder ones came from all along the line, east and west. More than once an entire flock, distinct by the unity of their calls, came into range and passed out of hearing, keeping up their regular formation with the precision of a swiftly moving but orderly body of horsemen. The great space of air above swarmed with life. Singly or in groups, large and small, or more seldom in a great throng the hurrying myriads pressed southward. It was a marvel and a mystery enacted under the cover of night, and of which only fugitive tidings reached the listeners below.

The next station chosen was the Washburn Observatory, over-

looking the largest of the lakes in the vicinity of the city. The writer was assisted by Winslow Mallery, to whose patience and accuracy is due not a little of the success attending these initial observations. It was proposed to watch the moon through a small six-inch telescope, and to count the birds as they passed across its surface in the southward flight. For convenience in keeping the record, the whole time of observation was divided into periods of fifteen minutes each and the count for each period kept distinct from the rest. The result exceeded all expectations and well repaid the inconvenience attending such experimental work. During the three nights of observation, Sept. 11, 12 and 13, 1897, a total of five hundred and eighty-three birds were counted, and forty-five during one fifteen-minute period. On the evening of the 12th, three hundred and fifty-eight were counted, the largest number for any one period being thirty-five. The number of birds seen during different hours of the night was very unequal. The maximum number of three per minute was reached at 10.30, and it diminished rapidly to a little more than one third of this number at midnight. From this time the number declined, with three considerable upward variations, to very near the zero point. As to the direction of flight very great diversity was also observed. The predominant direction up to ten o'clock was very nearly south, and but comparatively few birds varied from this. The diversity of direction, however, continued to increase till it reached its maximum between twelve and two o'clock. At this time the eight principal points of the compass were represented by numbers varying from three to twenty-eight; two-thirds of the whole number still maintaining a southerly direction.

The observations as to the number of birds and the direction of their flight tell substantially the same story. The first considerable falling off in the number of birds came at 11.15, and up to 10.45 they were observed to fly largely in one direction, not half that number for any period taking any other direction. Thus the intensity of the migratory movement, measured by the number of birds and the regular direction of their flight, is seen to be at its height early in the evening. The diminishing numbers and increasing variety in direction indicate plainly enough that during the time of observation other things besides migration

were taking place later in the night. This latter conclusion is borne out by the larger number of calls heard toward morning, which may be explained as arising from the effort to reassemble the scattered members of the migrating companies. As a general conclusion to be drawn from the whole observation, it would seem that the great mass of migrants thrusts itself rapidly forward for the first two or three hours in one main direction and that separate flocks maintained this movement many hours later. And that after the first advance was completed, the remainder of the night was spent in more miscellaneous movements, having for their purpose, partly at least, the collecting of the widely separated fragments of the different groups, and the selecting of suitable feeding grounds.

This fugitive glimpse into a new phase of bird life reveals many things besides the two chief points already noted. When one recalls the relatively small size of the moon's surface compared to the length of its path from east to west, within the range of vision, some idea of the whole number of birds passing this line may be obtained. Prof. A. S. Flint of the Washburn Observatory estimated that about nine thousand per hour passed during the entire period of observation, or a total of one hundred and sixty-eight thousand. And when the length of this line is compared to the breadth of the whole country over which birds move, the total number of migrating birds for a given area may be roughly estimated. This states in numerical fashion the meaning of the semi-annual migration of our birds. It falls as far short of expressing what the movement really is as does a census report of revealing the daily life of a city like New York or Chicago.

The movement of the birds across the field of vision irresistibly suggested the rapid, undulatory motion of animalculæ under high magnifying power. The time of passage varied from one-tenth to one-half a second. In most cases the movement of the wings was plainly visible, though occasionally a bird passed across like a flash. One bird hung for several seconds on the edge of the field of vision, poising itself by rapid motions of the wings. Several times a bird was seen to change its direction of flight completely, usually going off at right angles. Very rarely

were the birds numerous enough to be seen two at a time, though this happened once during each evening. Not infrequently currents of air seemed to aid or retard their flight. One bird was seen to move backwards across the field as a slowly flying bird is sometimes seen to do from the window of a swiftly moving train. Many of them sailed instead of flying across, occasionally flapping their wings to steady themselves.

On account of the short time each bird was in sight, and the difficulty of estimating their relative distances, not many of them could be identified. More Swamp Blackbirds were identified than any other, and next to them were the Meadowlarks, of which several flocks were observed. Besides these there were the Crow Blackbird, Sparrow Hawk, Yellow Hammer, and one species of Duck. Many of the birds, from their size and flight, must have been Warblers, but it was impossible to further identify them. A number of birds resembling Gulls were observed in large flocks, but nothing could be determined as to the species. The single Sparrow Hawk seen was moving leisurely along in no particular direction except that he seemed to be following the main stream of birds. His hesitating appearance showed how well concealed were his intended victims, though he had sufficient intimation of their presence to keep him on the track. A more thorough acquaintance with the appearance of the birds in flight would have added greatly to the value of the observations.

How the birds are guided in their nocturnal flight is perhaps the most puzzling question which rises in the mind of the observer. There are two possible solutions of this problem. They may be guided by the stars, or by the contour of the country, the lakes and river valleys. Certain it is that cloudy, and especially foggy nights are not favorable for flight. Birds lose their way and wander from their course as seamen do when there is neither sun nor star to guide them. It may be accepted as settled that birds are not possessed of an infallible instinct that guides them, otherwise they need not be disturbed by a fog. The results of the observations just cited show the same thing. That birds do wander from their course is seen from the great variety of directions taken by them during the night. Certainly not all in a given flock fly in one unvarying direction. Individ-

uals get separated or lost and fly in the widely divergent tracks already referred to. The sudden changes in direction that were observed in certain cases may tell the same story. These birds had perhaps lost their way, and hearing the calls of their comrades, wheeled about to join them. The not uncommon sight of birds of one species in a flock of a wholly different kind also shows how frequently they get lost during their migrations.

The turning of the telescope upon this comparatively unknown field suggests endless possibilities. It affords us a means of surveying a plexus of bird life marvelously intricate and full of discoveries. There is revealed to us a new side of the wonderfully human life of the bird. We can sit quietly by while the march of feathered legions goes on, — unsuspected spectators of one of the great events in the world of flying things. The dangers and difficulties attending such an exodus are very real. Along the flanks of every company or hovering in the rear are the birds of prey watching to pick off every careless straggler. The earliest comers are exposed to all the risks of sudden changes in the weather, and great storms like that of 1895, which destroyed so many Bluebirds. The strain of such a journey is not inconsiderable, and it effectually weeds out all but the most hardy individuals; the young, the sick and the old being the first to fall by the way. Twice each year the migratory birds attempt the marvelous feat and perform it with such silence and celerity that it goes on almost unnoticed. But if each bird in his nocturnal passage were as luminous as a meteor, how the heavens would blaze during the migrating season, and how wonderful would seem their journeyings to and fro. Not the less wonderful do they seem to the true bird-lover, though he can catch only stray glimpses of those numberless hosts that move along their airy highways with each recurring season.

The fewness of such detailed observations as are here briefly sketched leads to the conclusion that their value is not appreciated as it should be. Those who study birds for the pure love of it may find here a delightful glimpse into a fresh field. A telescope is not a necessity, good field glasses will show all but the smallest birds. The larger the number of observers the more accurate will be the general conclusions arrived at in the end.

Each may do something of value while studying in a new way the familiar problems of bird life. The writer hopes simply to encourage others to work along a line which has been of so much interest to him and which seems so full of new material.

A HISTORICAL NOTICE OF ROSS'S ROSY GULL (*RHODOSTETHIA ROSEA*).¹

BY JOHN MURDOCH.

As I am one of the very few naturalists who ever had the good fortune to collect more than a few straggling individuals of this beautiful and still rare Gull, or, indeed, to see the bird in anything like large numbers, I have always felt a great interest in the species. The bird, indeed, should be of interest to all naturalists, for although it has been known to science for seventy-five years, and although I have seen literally thousands of them on the wing, there are still not more than 110 specimens known to be in existence in collections, and most of these have been procured since 1880. The great difference between the actual numbers of the bird and its representation in collections is plainly due to some remarkable peculiarity in its habits and geographical distribution. I hope to show what this peculiarity is in the present paper, in which I have tried to present all that we know of the history of the species.

The bird, of course, is well known to ornithologists, but as all my hearers are not ornithologists, it will be well to describe it briefly before going on to give an account of its discovery. It is a graceful little Gull about the size of a Pigeon, and not unlike the little Bonaparte's Gull which is so common along our coast. It is, however, strikingly different from all other Gulls in two important particulars. In the first place, it is the only Gull

¹ Read before Section F, American Association for the Advancement of Science, August 28, 1898.